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THE DIFFERENTIAL DIAGNOSIS OF PAIN IN THE ANTERIOR CHEST

It is clearly impossible within the limits of this article to discuss adequately all the conditions that may cause pain in the anterior chest, and no attempt will be made to do so. Emphasis will be placed upon a few major causes, of which pain arising in the heart is the most important by reason of its frequency and its potential or actual seriousness.

CARDIAC PAIN

Pain arising from inadequacy of the coronary blood flow is customarily divided into three main types: angina pectoris, coronary thrombosis with myocardial infarction, and coronary insufficiency. The subgroup currently known as subendocardial necrosis will not be discussed. It is recognized that the terms coronary thrombosis and myocardial infarction are not synonymous, since one may occur without the other, but in the following discussion the terms coronary thrombosis, cardiac infarction, and myocardial infarction will be used synonymously.

The time-honored name angina pectoris has many synonyms: angina, angina of effort, anginal pain, anginal heart failure, cardiac pain, and coronary pain. In most instances it has but one manifestation, namely, discomfort or pain in the anterior chest, sometimes radiating widely from its original location. Through generations of medical experience, it has been established that this symptom has certain characteristics that are so nearly constant and invariable as to permit confident recognition. The most important are these:—

1. It is almost always a sense of constriction, tightness, or pressure rather than actual pain, although it may rise to the level of pain if the provocative factors continue. 2. It is located beneath the sternum, although commonly described by doctors as precordial. If the term precordial is used to designate that portion of the chest overlying the heart to the left of the sternum, then it is quite inaccurate and misleading to describe anginal pain as precordial. It is accurate, *and very important,* to describe it as substernal. 3. If it radiates from the point of its original and major location, it usually goes to the throat, side of the neck, shoulder, and inner aspect of the upper arm; sometimes it extends into the ulnar aspect of the forearm and the little and ring fingers. It may radiate into the jaws, back or epigastrium. 4. It is brief in duration, seldom lasting more than two minutes after cessation of physical effort and often subsiding within 15 to 30 seconds. Patients often say that it lasts ten or more minutes, but, when asked to time it accurately, they usually report that it disappears in two minutes or less. 5. It is closely and almost invariably related to increased work of the heart, the commonest provocative factors being physical exertion and emotional excitement. 6. It is reproducible. The same kind and intensity of discomfort will occur again and again upon repetition of the same effort and will disappear each time in approximately the same number of seconds. 7. It may be present, even in severe form, in the complete absence of any abnormal findings in the physical examination, the usual laboratory tests, x-ray study of the heart, and the resting electrocardiogram. 8. It is usually relieved very promptly by the administration of nitroglycerine, although sometimes not more quickly than by rest alone. Far more important, it is usually prevented completely if nitroglycerine is used just before physical effort or exposure to emotional excitement.

Of these eight characteristic features, several are especially important in distinguishing this condition from others: the substernal location, brief duration, radiation to the *inner* aspect of the upper arm, reproduction by repetition of the same effort, relationship to increased work of the heart, and the preventive action of nitroglycerine. *The diagnosis of angina rests upon the history and not upon physical examination or any laboratory test now available.*

There appears to be unanimous agreement among competent authorities that the cause of this remarkable symptom is a discrepancy between the needs of the heart for blood and oxygen on the one hand and the available supply on the other; discomfort occurs whenever the demands of the heart for oxygen are greater than the supply available at that instant. Consequently it is not surprising that anginal pain arises in those conditions that increase the work of the heart without a simultaneous increase in its blood supply: conditions such as hyperthyroidism, paroxysmal tachycardia, physical exercise, emotional excitement (which is the equivalent of exercise), exposure to a cold atmosphere, and sometimes aortic insufficiency. It is equally clear that anginal pain is to be expected whenever the heart's supply of oxygen is diminished without a corresponding and simultaneous decrease in its work. An excellent example of this is found in the occurrence of typical substernal squeezing pain on effort in young and otherwise healthy individuals if there is moderately severe anemia. The symptom disappears when the blood count and hemoglobin have been restored to normal levels.

There is wide divergence of medical opinion as to the occurrence, frequency, and importance of spasm of the coronary arteries or arterioles, but, if this does in fact occur in human beings, it obviously causes a decrease in coronary blood flow. At times it is tempting to assume reflex spasm of these vessels to explain attacks of pain that otherwise remain

obscure, but it is seldom necessary to invoke this explanation. By far the commonest cause of anginal pain is a reduction of the blood flow due to narrowing of the coronary arteries by those changes in the intima known as atherosclerosis.

CORONARY THROMBOSIS WITH MYOCARDIAL INFARCTION

Between simple angina, which has just been described, and coronary thrombosis with cardiac infarction there are usually conspicuous differences that permit a confident diagnosis. Not only does coronary thrombosis usually cause pain of greater severity and longer duration, but also there are subsequent findings that serve to identify it clearly. Pallor, weakness, sweating, and dyspnea commonly accompany the onset of pain, and later there are usually fall in blood pressure, fever, leukocytosis, and increase in the sedimentation rate. Most important of all are the highly distinctive changes that occur in serial electrocardiograms. Despite these usual differences, it is important to emphasize that the relatively sudden onset of typical anginal pain on effort should always arouse the suspicion that cardiac infarction might have occurred several days before.

CORONARY INSUFFICIENCY

There is a third condition that is usually regarded as standing between angina and coronary thrombosis. In many instances it is characterized by pain which is longer in duration than that of angina and shorter than that of coronary closure. It may or may not be related to effort. It may or may not be relieved by nitroglycerine. The changes indicating tissue destruction (fever, leukocytosis, increased sedimentation rate) usually do not occur or are border-line in degree. Changes in electrocardiograms characteristic of cardiac infarction do not occur; if changes are present, they usually consist of transient depression of the S-T segments. This condition is commonly designated as coronary insufficiency or coronary failure. The terms are far from ideal, since they could be applied with equal reason to each of the three conditions now under discussion, but they have the sanction of wide usage and a preferable name has not been introduced.

The diagnosis can be made sometimes on the basis of the history and the resting electrocardiogram taken shortly after the onset of symptoms. It is made far more often because of changes in electrocardiograms taken under conditions which subject the heart to stress. Several stress tests involve trips over a standard two-step platform at a constant rate, either for a specified number based on the age, sex, height, and weight of the patient, or until the patient experiences anginal pain or uncomfortable dyspnea. Electrocardiograms are taken after the conclusion of the effort. The test is regarded as positive, and coronary insufficiency is said to be present, if these display certain changes that were not present in the control curves taken before the test. It is important that electrocardiograms be taken over a period of at least five minutes after conclusion of the effort, inasmuch as conspicuous changes may be present at the end of this period, although absent during the first 2 or 3 minutes after exercise. Experienced observers have suggested that no curves be taken until after the heart rate has returned to the pre-exercise level.

The anoxemia test is based upon the presence or absence of certain changes in electrocardiograms taken after the patient has breathed 10 per cent oxygen for twenty minutes.

DISSECTING ANEURYSM

Dissecting aneurysm of the aorta may cause symptoms very similar to those of cardiac infarction. In fact, if the patient dies within a few hours, it may be impossible to determine without postmortem examination which of the two conditions was present. If he survives, there are features which may help in the differential diagnosis. Dissecting aneurysm usually occurs in hypertensive persons, and the blood pressure commonly remains elevated for hours or days, whereas in cardiac infarction of comparable severity there is almost invariably a dramatic fall in pressure. The pain of dissecting aneurysm is often of agonizing severity, requiring huge doses of morphine; even these sometimes fail to give relief. This observation may be the first to suggest the correct diagnosis. The blood pressure may differ greatly in the two arms, and interference with the carotid arteries may cause cerebral signs or even complete hemiplegia. Electrocardiograms do not display the characteristic pattern of cardiac infarction unless the dissection proceeds backward and causes closure of a coronary ostium. Such backward dissection may separate the aortic valve leaflets and thereby cause a diastolic murmur which was not present earlier. Forward dissection often leads to dramatic changes in the quality and location of the pain from hour to hour and day to day. Logue and Sikes' have recently described a new sign, namely, pulsation of either the right or left sternoclavicular joint.

PULMONARY EMBOLISM

Pulmonary embolism may likewise cause pain and other clinical features that lead to a suspicion of cardiac infarction. In both conditions there may be very severe substernal pain, dyspnea, cyanosis, tachycardia, fall in blood pressure, and shock. In many instances the attendant circumstances lead to the correct diagnosis. For example, if the symptoms occur shortly after childbirth or surgical operation, in a patient known to have auricular fibrillation, phlebitis, or varicose veins, or in anyone long confined to bed, pulmonary embolism would be the tentative diagnosis. On the other hand, if they occur in a man above 40 years of age in the absence of the above factors, in a hypertensive or anginal patient, coronary thrombosis would be one's first thought.

Electrocardiograms may be of crucial importance, since almost without exception these will reveal conclusive evidence of cardiac infarction if it has occurred. There is no single pattern that is equally distinctive of pulmonary embolism; the very fact that many patterns have been described indicates that the diagnosis rests upon the absence of changes typical of cardiac infarction.

PERICARDITIS

It is not often that the pain of acute fibrinous pericarditis is confused for long with angina or cardiac infarction, for it is sharp rather than dull and is usually increased by inspiration, coughing, or bodily movements. It may be beneath the sternum but is more commonly precordial; it may vary in location frequently. Electrocardiograms may be helpful if pericarditis is suspected in the absence of a friction rub, since they often reveal elevation and upward concavity of the S-T segments, followed by inversion of the T waves. This pattern differs from that of cardiac infarction because of the absence of reciprocal changes in Leads 1 and 3.

There is another type of pericarditis that sometimes causes greater difficulty in diagnosis, the so-called acute, benign, non-specific pericarditis. This occurs chiefly among younger patients, is usually mild, and should not be confused often with cardiac infarction. However in some the pain may be fairly severe, substernal in location with radiation into the upper arm, and may be accompanied by fever and mild leukocytosis. If electrocardiograms are taken soon after the onset of symptoms, they will reveal the pattern of pericarditis already mentioned, but, if they are taken after some days, they

may display deep inversion of the T waves in all limb and precordial leads, similar to that found in extensive infarction of the anterior, lateral, and posterior walls of the ventricle but without the QRS changes found in the latter. Furthermore, the benign course of the disease is not consistent with the belief that extensive infarction has occurred.

PULMONARY HYPERTENSIVE PAIN

Viar and Harrison[2] have recently called attention to a type of pain in the chest that may lead to an erroneous diagnosis of coronary artery disease. Since the one constant feature other than pain has been clinical evidence of increased pressure in the pulmonary vascular circuit, they suggest that it be termed "pulmonary hypertensive pain." It may resemble anginal pain in location, radiation, intensity, and quality, and in its association with physical effort. Most of their patients had one of the following:— 1. lesions of the mitral valve; 2. congenital anomalies of the heart; 3. primary diffuse disorders of the lungs, especially asthma and emphysema; 4. disorders of the pulmonary artery, especially embolism. It seldom occurs in those who have pulmonary hypertension secondary to left ventricular failure. The more important guides to the correct diagnosis are:—1. a history of long-standing cough; 2. intermittent or persistent cyanosis, usually present during the attacks of pain; 3. association of the pain with dyspnea; 4. the presence of pain on breathing; 5. clinical evidence of right ventricular hypertrophy (this is one of the most important signs); 6. absence of fever, leukocytosis, and rapid sedimentation rate unless there is coexistent infection or infarction of the lung; 7. little or no effect of nitroglycerine, in contrast to the dramatic relief produced by this drug in angina.

SPASM OF G-I TRACT

The condition that probably leads most often to erroneous diagnoses of cardiac pain is spasm of some portion of the gastro-intestinal tract. This may be in the esophagus, the cardia, the pylorus, or more diffusely in the colon, especially the transverse colon. In those suspected of having cardiac pain the major symptom is discomfort in the left side of the chest, usually precordial and rarely localized beneath the sternum. This may last for hours or even days at a time. It seldom has any fixed relationship to physical effort or emotional excitement. It may vary in location from day to day; it may extend as high as the clavicle, to the anterior axilla, and sometimes to the left side of the back. Its point of maximal severity may be under the breast in women or in the corresponding location in men. It is seldom relieved by nitroglycerine, or the relief is variable and unpredictable. It is usually abolished for long periods by the administration of antispasmodic drugs. Changes in the electrocardiogram indicative of coronary insufficiency or thrombosis are absent unless the patient had these conditions previously.

This condition would not be confused with cardiac pain so frequently if attention were given to those characteristics which stamp it clearly as noncardiac:—the wide and variable distribution, long duration, absence of relationship to effort and excitement, failure of nitroglycerine to provide relief, and the effect of antispasmodic drugs.

HIATUS HERNIA

Hiatus hernia of the stomach deserves far more comprehensive discussion than space will permit, for it may simulate either angina or coronary thrombosis, and the differentiation is not always easy. Nuzum[3] recently reported that of 100 private patients with a clinical diagnosis of angina 25 were found to have hiatus hernias; after careful study 7 of these were judged to have no coronary artery disease. The symptoms in these were ascribed to the hernias. Not infrequently the pain caused by hernia is so prolonged as to lead to a tentative diagnosis of cardiac infarction, which can usually be excluded by the appropriate laboratory tests repeatedly mentioned.

Several possible differences between anginal and hernial pain should be kept in mind. That associated with hernia is more likely to occur when the patient is lying down or leaning forward; a change in posture sometimes gives almost instant relief. It usually lasts longer than the brief discomfort of angina and very seldom has the same close relationship to physical effort or emotional excitement. At times it appears to be relieved by nitroglycerine, while at other times this drug is without effect; this variability in the response to nitroglycerine should always suggest hernia rather than angina. But the possibility of coexisting hernia and angina must be recognized; a number of such instances have been reported.

Many case histories have been published to illustrate the close similarity between angina and the pain of hernia, but, if one reads these with a critical eye and a knowledge of the extraordinarily constant features of angina, it becomes clear that most of them illustrate differences rather than similarities, and in many it is difficult to find any justification for a suspicion of angina. The puzzling cases are those in which both conditions are present. Perhaps the major emphasis in this limited discussion should be placed upon the fact that pain suggestive of angina in several respects, *but differing sharply in others*, may be caused by hiatus hernia.

NEUROCIRCULATORY ASTHENIA

It has been stated often that there may be great difficulty in distinguishing between the pain associated with neurocirculatory asthenia and that of angina. Actually, if one keeps clearly in mind the characteristic features of cardiac pain enumerated earlier, it is clear that the pain of neurocirculatory asthenia usually lacks most of them. It is seldom or never localized to the substernal area, as angina usually is, although this area may be included in pain of wide distribution. It is usually more diffuse over the precordium and may be most intense near the apex of the heart or in the anterior axilla. It usually lasts for many minutes or even hours, which angina does not, and there may be residual tenderness over the affected area after the acute discomfort has subsided. It may occur in the absence of physical effort or any known emotional excitement or may be induced by these factors and continue long after they have ceased. Neurocirculatory asthenia is now regarded as a form of anxiety neurosis, and those who suffer from it usually display clear evidences of an anxiety state: dilatation of the pupils, profuse sweating, tachycardia, trembling, physical weakness, and sometimes pronounced dyspnea. These are not the accompaniments of angina. If cardiac infarction is suspected, it can be excluded by the absence of fever, leukocytosis, rapid sedimentation rate, and changes in electrocardiograms.

SPONTANEOUS PNEUMOTHORAX

It is not often that spontaneous pneumothorax causes symptoms closely resembling those of cardiac infarction, but occasionally there is very severe pain, accompanied by pallor, sweating, dyspnea, tachycardia, faint heart sounds, and fall in blood pressure. Theoretically, the correct diagnosis should be made easily by physical examination of the lungs, but actually the changes in percussion note and breath sounds on the affected side may be so slight during the first few hours as to escape detection by competent physicians. The relative youthfulness of most patients with this condition should

make one hesitant to diagnose cardiac infarction, and the absence of changes in electrocardiograms and other laboratory tests will serve to exclude it. The correct diagnosis is immediately evident on fluoroscopic examination or x-ray films, and usually can be demonstrated by physical examination within several days.

There is not space for consideration of gall bladder disease or arthritis of the dorsal or cervical spine, both of which may cause pain in some part of the anterior chest. It is the conviction of the present writer that these rarely imitate cardiac pain closely enough to cause serious or lasting difficulty in diagnosis. The differentiation can be made readily in most instances on the basis of the history, x-rays, and electrocardiograms.

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NEW ADDRESS FOR AMERICAN HEART ASSOCIATION

On and after September 20, 1952, the office of the American Heart Association will be located at the following address: 44 East 23rd Street, New York City 10, New York. Phone: GRamercy 7-9170.

AMERICAN HEART ASSOCIATION RESEARCH GRANTS-IN-AID

Applications for American Heart Association Research Grants-in-aid for the fiscal year 1953-1954 must be postmarked not later than December 1, 1952. Information and application forms may be obtained from the Medical Director.

SUBSCRIPTION RATES FOR *CIRCULATION-RESEARCH*

Subscription rates for the bimonthly journal, *CIRCULATION-RESEARCH*, the first issue of which will appear in January 1953, have been set below publication cost to encourage the widest possible readership. The Association will assume the difference as part of its professional education program. *Research Journal Membership-Subscriptions*, available through the Association and most of its affiliates, include the monthly bulletin, *Modern Concepts of Cardiovascular Disease*, and admission to the Association's annual Scientific Sessions.

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ANNUAL MEETING AND SCIENTIFIC SESSIONS

The Twenty-Ninth Annual Meeting and the Twenty-Sixth Scientific Sessions of the American Heart Association will be held at the *Hotel Chelsea* in Atlantic City, N. J., *April 8-12, 1953*, immediately preceding the annual meeting of the American College of Physicians. All those desiring to attend should make room reservations at the earliest possible date. (The Hotel Chelsea is located on the Boardwalk at Morris Avenue, 5 short blocks *south* of the Convention Hall.) The Scientific Sessions will be held on Thursday, Friday, Saturday and Sunday, April 9, 10, 11 and 12.

PAPERS FOR THE SCIENTIFIC SESSIONS

All those desiring to present papers at the Association's Scientific Sessions should submit abstracts *in triplicate* of the proposed presentation to Dr. Andre Cournand, Chairman of the Program Committee, c/o American Heart Association, 44 East 23rd Street, New York 10, N. Y., not later than *January 1, 1953*. Abstracts should not be longer than 300 words and must contain in summary form, a specific statement of the results obtained or conclusions reached (not merely a statement that results or conclusions will be presented, or discussed at the meeting.)